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ON THE THIRD SPACESHIP-SATELLITE

by

I. A. Savenko  
N. F. Pisarenko  
P. I. Shavrin  
S. F. Papkov

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MEASUREMENT OF THE ABSORBED DOSE \*  
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by I. A. Savenko,  
N. F. Pisarenko  
P. I. Shavrin  
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The radiometric instrumentation installed aboard the third Soviet spaceship-satellite, which was put into orbit on 1 December 1961 with a 187 km perigee and 265 km apogee and a 65° inclination to the equator plane, was similar to that installed on the 2nd spaceship-satellite [1]. It consisted of two scintillation and one gas-discharge counters, and it differed from that of the latter by the following:

a) instead of two alternately-operating gas-discharge counters, only one was installed, operating continuously, so that it led to an increase of the volume of the obtained information;

b) The sensitivity of the channel measuring energy liberation in the <sup>NaI</sup>NaI(Tl) crystal was increased by more than one order;

c) the high-voltage batteries feeding FEU and gas-discharge counters were replaced by semi-conductor voltage transformers.

The measurements on the 2nd spaceship-satellite permitted to establish the distribution of radiation and to measure the absorbed dose at 320 km above the Earth's surface [2]. The trajectory of the 3rd spaceship-satellite lying about 100 km lower provided the possibility of making more precise the lower

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\* Izmereniye pogloshchennoy dozy na tret'yem kosmicheskoy korable-sputnike.

boundary of the radiation belts.

Fig.1 shows the counter readings from the third spaceship-satellite for a greater part of its trajectory. The obtained pattern differs little from what was observed during the previous flight of the 2nd spacecraft. To count maxima, determined by the latitude effect of cosmic rays, superimposed are the peaks caused by craft's passing through portions of radiation belts. The geographical position of these portions did not substantially change by comparison with that obtained on the 2nd spaceship-satellite [2, 3], but the brehmstrahlung intensity from the electrons of the inner radiation belt decreased by about 2.5 times in the Northern hemisphere, and by 30% in the Southern hemisphere. The quantity of the mean energy liberation of brehmstrahlung in the <sup>NaI</sup>~~NaI~~(Tl) crystal, determined by the same method as in [1], constitutes  $2 \cdot 10^5$  ev per quantum.

Substantially decreased was the brehmstrahlung intensity in the region of the Brazilian magnetic anomaly. The intensity of the proton component in that region also decreased by about one order.

The geographical distribution of the power of the absorbed dose, determined by energy liberation in the <sup>NaI</sup>~~NaI~~(Tl) crystal (Fig.2) practically coincides with the distribution obtained on the 2nd spaceship. A certain difference is only observed in the South Atlantic region.

The mean power of the absorbed dose constitutes 6.9 per 24 hours, in complete agreement with the results obtained on the 2nd spaceship-satellite. At the same time, the integral dose for one convolution varied within the limits from 0.35 to 0.6 mrad/day, depending upon the geographical position of the convolution.

Isolines of the counting rate of the scintillation counter are brought out in Fig. 4 of reference [3]. They characterize the disposition of radiation belts, inasmuch as the scintillation counter registers the brehmstrahlung with high efficiency. The greatest contribution to the aggregate dose is made by radiation belts in the South Atlantic region, in the South Pacific, and above North America. However, this contribution is not great as a whole: Just as during the flight of the 2ns spaceship-satellite, the main part of the dose is determined by cosmic rays.

It must be noted that by comparison with measurements on the 2nd spaceship-satellite, the counting rate decreased in the equatorial regions by 30 percent as an average (intensity decrease from  $5.5$  to  $4.1 \text{ cm}^{-2} \text{ sec}^{-1}$ ), while the energy liberation in the crystal and the counting rate of the Geiger counter practically did not change in the indicated regions. This is evidence of the fact that this decrease is conditioned by  $\gamma$ -quanta of small energies.

Comparison of energy liberation in the <sup>NaI</sup>(Tl) crystal and of the counting rate of the Geiger counter STS-5 (Fig. 1) shows, that these two parameters coincide rather exactly in the character of their variation, and the corresponding curves are nearly similar. The physical cause of this phenomenon consists in the following: The energy liberation of penetrating particles in the NaI(Tl) crystal constitutes a scale magnitude of  $10^7 \text{ eV}$ , while the liberation of energy for one brehmstrahlung quantum is  $\sim 10^5 \text{ eV}$ , i. e. by two orders less. At the same time, the efficiency of the Geiger counter constitutes for the penetrating charged particles 100%, and for the X-radiation  $\sim$  near 1%, i. e. also by two orders less. That is why the relative accretion of energy liberation in the crystal at hitting the outer radiation belt coincides well in the order of magnitude with the relative accretion of the counting rate of the Geiger counter. STS-5. This makes the Geiger counter a practical instrument for dosimetric

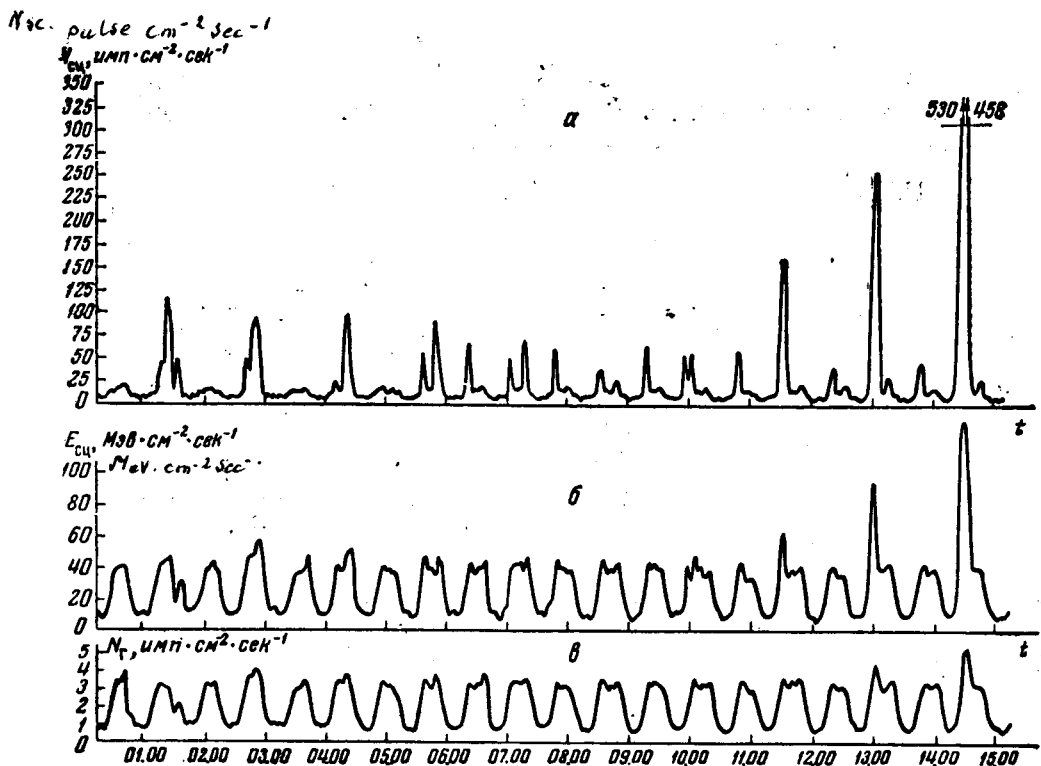


Fig. 1. Pickup readings over one of the portions of the third spaceship-satellite's trajectory on 1 Dec. 1960:

a — intensity registered by the scintillation counter with a threshold of 25 keV; — energy liberation in the crystal of the scintillation counter; — intensity, registered by the gas-discharge counter STS-5.

measurements under these conditions, particularly if we take into account the "course with the hardness" in the <sup>NaI</sup>NaI(Tl) crystal.

Thus, the dosimetric measurements conducted on the 2nd and 3rd spaceships-satellites provided the possibility of obtaining the following basic results:

Maps of absorbed doses' distribution along the terrestrial globe were obtained in the 180 — 250 and 306 — 339 km altitude ranges.

The existence of the outer radiation belt at the given heights was revealed, and its boundaries, its mean energy and the intensity of the radiation within it were determined.

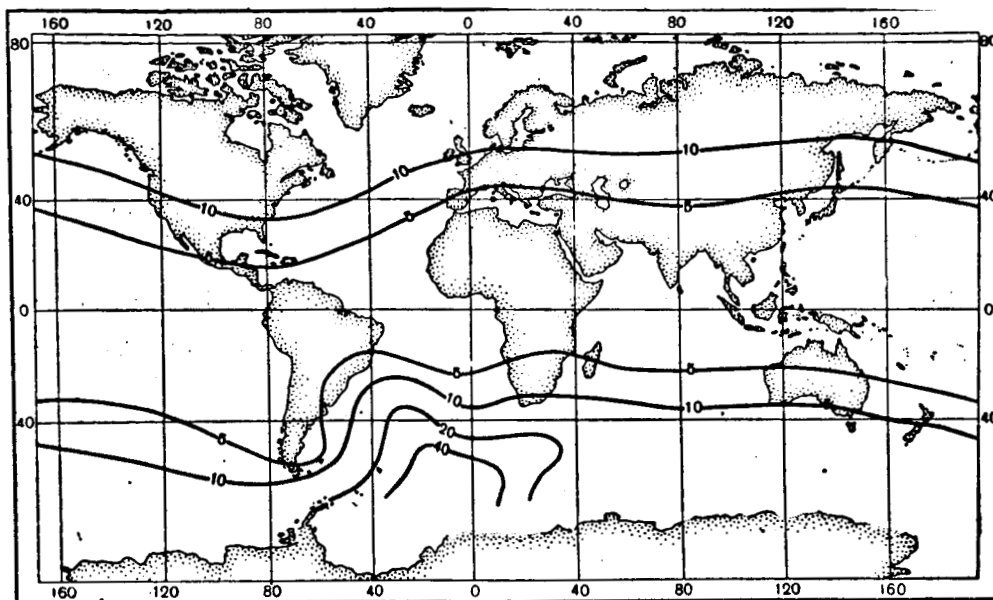


Fig. 2. Distribution of the power of the absorbed dose according to measurements on the 3rd spaceship.

Numbers over lines indicate the power of the dose in mrad/day

The fact of the inner belt lowering in the region of the Brazilian anomaly was established.

The presence of comparatively intense fluxes of weakly-penetrating corpuscular radiation in the near-equatorial regions was ascertained.

The principal result of the indicated investigations is the conclusion on the practical security of cosmic flights at altitudes below 350 km of long duration under conditions of absence of chromospheric flares in the Sun. Besides, the comparison of experimental data obtained on the 2nd and 3rd spaceships-satellites provides the possibility of making practical conclusions on the degree of radiation danger during flights at great heights.

To conclude, the authors express their gratitude to A. F. Tupkin, Yu. V. Trigubov, L. A. Smirnov for their assistance in the preparation of the experiment, and also to T. V. Kurakina, and V. P. Spirina for shaping up the results.

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